

**CLAIMS:**

1. A composite sol gel formulation comprising:  
a slurry having up to 90% by weight of inorganic powder dispersed in a colloidal sol gel solution prepared from metal organic precursors wherein said sol gel solution has an expanded and preferably discontinuous gel network;  
said coating layer converting to a thick inorganic coating upon firing to a temperature of at least 300°C.
2. The composite sol gel solution of claim 1 wherein:  
said colloidal sol gel is made by hot water peptization of metal alkoxide with an acid;  
said acid having an ionization constant of at least  $1 \times 10^{-5}$ , a noncomplexing anion with the metal species of the alkoxide; and,  
the molar ratio of said acid to said metal alkoxide is selected to cause said gel network to be expanded and preferably discontinuous.
3. The composite sol gel solution of claim 2 wherein said colloidal sol gel solution contains an inorganic acid and has an acid/metal alkoxide molar ratio greater than 0.10.
4. The composite sol gel solution of claim 3 wherein:  
said acid/metal alkoxide molar ratio is from 0.15 to 1.0; and,  
said slurry has a thixotropic nature enabling its application to a substrate by shear thinning followed by coating on said substrate and subsequent re-gelling.
5. The composite sol gel solution of claim 2, 3 or 4 wherein said inorganic acid is a member selected from the group consisting of nitric acid, hydrochloric acid and perchloric acid.
6. The composite sol gel formulation of claim 2, 3 or 4 wherein said acid has been produced by adding a water soluble acid salt having a noncomplexing anion with the metal species of the alkoxide.

7. The composite sol gel formulation of claim 2 wherein said colloidal sol gel contains an organic acid and has an acid/metal alkoxide molar ratio of greater than 0.25.
8. The composite sold gel formulation of claim 7 wherein:  
said acid/metal alkoxide molar ratio is from 0.5 to 4.0; and  
said slurry has a thixotropic nature enabling its application to a substrate by shear thinning followed by coating on said substrate and subsequent re-gelling.
9. The composite sol gel formulation of claim 7 or 8 wherein said organic acid is a member selected from the group consisting of monochloroacetic acid, dichloroacetic acid, trichloroacetic acid and formic acid.
10. The composite sol gel formulation of claim 1 wherein said colloidal sol gel is alumina.
11. The composite sol gel formulation of claim 10 wherein said alumina sol gel is made from a member selected from the group consisting of aluminum isopropoxide, aluminum propoxide, aluminum n-butoxide, aluminum sec-butoxide, aluminum tert-butoxide, aluminum methoxide and aluminum ethoxide.
12. The composite sol gel formulation of claim 1 wherein said colloidal sol gel is at least one member selected from the group consisting of alumina, titania, zirconia and silica.
13. The composite sold gel formulation of claim 1 wherein said colloidal sol gel solution has a pH of no greater than 3.8.
14. The composite sol gel formulation of claim 1 wherein said colloidal sol gel solution has a pH of no greater than 3.6.
15. The composite sol gel formulation of claim 1 wherein said colloidal sol gel solution has an alkoxide molar concentration of between 0.5 and 2.0.
16. The composite sol gel formulation of claim 1 wherein said inorganic powder is a member selected from the group consisting of oxide, nitride, carbide, silicide, graphite and silver.

17. The composite sol gel formulation of claim 1 wherein said ceramic coating is at least 100 microns thick.
18. The composite sol gel formulation of claim 1 wherein said formulation is capable of forming a ceramic coating of at least 1 mm thick by repeated coating and firing.
19. The composite sol gel formulation of claim 1 wherein said inorganic powder has an average particle size of from 1 to 100 microns.
20. The composite sol gel formulation of claim 1 wherein said inorganic powder has an average particle size of from 1 to 30 microns.
21. A process for producing a gamma alumina washcoat on inside channels of honeycomb monoliths and close packed structures comprising the steps of:
  - (i) forming a slurry having up to 90% by weight high surface area ceramic powder in a colloidal alumina sol gel containing an acid and a metal alkoxide;
  - (ii) said acid having an ionization constant of at least  $1 \times 10^{-5}$  and having a noncomplexing anion with the metal species of the alkoxide;
  - (iii) increasing the molar ratio of said acid to said metal alkoxide to cause said gel network to become expanded and preferably discontinuous;
  - (iv) coating said inside channels with said slurry to form a coating layer thereon;
  - (v) allowing said coating layer to gel;
  - (vi) converting said coating layer to a ceramic layer by firing to a temperature of at least 300°C;
  - (vii) repeating steps (iv) through (vi) as necessary to form a ceramic coating having a desired thickness.
22. The process of claim 21 wherein:

said high surface area ceramic powder is a member selected from the group consisting of gamma alumina, silica, alumina-silica, titania and zirconia.

23. The process of claim 21 wherein said metal alkoxide is a member selected from the group consisting of aluminum isopropoxide, aluminum propoxide, aluminum n-butoxide, aluminum sec-butoxide, aluminum tert-butoxide, aluminum methoxide and aluminum ethoxide.
24. The process of claim 21 wherein said colloidal sol gel is a mixture of alumina and another metal oxide.
25. The process of claim 24 wherein said other metal oxide is a member selected from the group consisting of zirconia, silica, titania and magnesia.
26. The process of claim 21 wherein said acid is an inorganic acid and said molar ratio is increased in step (iii) to a molar ratio of greater than 0.10.
27. The process of claim 26 wherein said molar ratio is from 0.15 to 1.0; and, said slurry has a thixotropic nature enabling its application to said inside channels by shear thinning followed by coating on said inside channels and subsequent regelling.
28. The process of claims 21, 26 or 27 wherein said acid is a member selected from the group consisting of nitric acid, hydrochloric acid, perchloric acid, and an acid produced by adding a water soluble acid salt having a noncomplexing anion with the metal species of the alkoxide.
29. The process of claim 21 wherein said acid is an organic and in step (iii) is added in an amount sufficient to cause said molar ratio to be greater than 0.25.
30. The process of claim 29 wherein said acid is added in an amount sufficient to yield a molar ratio of from 0.25 to 2.0; and, said slurry has a thixotropic nature enabling its application to said inside channels by shear thinning followed by coating on said inside channels and subsequent regelling.
31. The process of claim 29 or 30 wherein said acid is a member selected from the group consisting of acetic acid, monochloroacetic acid, dichloroacetic acid, trichloroacetic acid and formic acid.

32. The process of claim 21 wherein the colloidal sol gel has a pH not exceeding 3.8.
33. The process of claim 21 wherein the colloidal sol gel has a pH not exceeding 3.6.
34. The process of claim 21 wherein said desired thickness is at least 100 microns.
35. The process of claim 21 wherein said desired thickness is at least 200 microns.
36. The process of claim 21 wherein said desired thickness is at least 300 microns.
37. The process of claim 21 wherein said desired thickness is 1.5 mm.
38. The process of claim 21 wherein said gamma alumina has an average particle size of from 1 to 100 microns.
39. The process of claim 38 wherein said gamma alumina has an average particle size of from 1 to 20 microns.
40. A catalytic support structure having a thick sol gel washcoat produced according to the process of claim 21.
41. The catalytic support structure of claim 40 wherein:
  - said washcoat is applied to honeycomb monoliths;
  - said high surface area ceramic is selected from the group consisting of gamma alumina powder silica, alumina/silica blends, titania and zirconia.
  - said acid to metal alkoxide ratio in step (iii) is increased to cause said gel network to be thixotropic; and,
  - including the further step of shearing said slurry to form a shear thinned slurry for application in step (iv).